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**Wagner
Free Institute
of Science
of Philadelphia**



**Annual
Announcement
1915-16**

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Wagner
Free Institute of Science
of Philadelphia

ANNUAL
ANNOUNCEMENT
Sixty-Eighth Year



Philadelphia
1915

TRUSTEES.

President, Samuel Wagner.

Secretary, Joseph Willcox.

Treasurer, J. Vaughan Merrick.

Sydney T. Skidmore. Harrison S. Morris.

Samuel T. Wagner. Henry Leffmann, *Chairman*.

FACULTY.

William Healey Dall, A.M., Sc.D.

Honorary Professor of Invertebrate Paleontology.

Henry Leffmann, A.M., M.D., Ph.D.

Honorary Professor of Chemistry.

William B. Scott, A.M., Ph.D., LL.D.

Honorary Professor of Geology.

George F. Stradling, Ph.D.

Honorary Professor of Physics.

Samuel Tobias Wagner, B.S., C.E.

Professor of Engineering.

Spencer Trotter, M.D.

Professor of Zoölogy.

Samuel C. Schmucker, Ph.D.

Professor of Botany.

Leslie B. Seely, B.A.

Professor of Physics.

Charles H. LaWall, Ph.M.

Professor of Organic Chemistry.

David W. Horn, Ph.D.

Professor of Inorganic and Physical Chemistry.

Mayville W. Twitchell, Ph.D.

Geology.

John G. Rothermel, *Director.*

Historical Note.

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the

hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed entirely into the hands of a Board of Trustees, and since then many improvements have been made in the building, and extensive additions to its equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

The lecture-room is capable of seating about six hundred persons and is equipped with excellent lecture facilities. The collection of physical apparatus comprises many of the older forms which have historic interest and a large number of the most recent invention and construction.

FACILITIES FOR INSTRUCTION.

LECTURES AND CLASS-WORK.

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly

at the close of each lecture, partly by written exercises. The museum and reference library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Free Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

The lecture-hall is provided with the latest apparatus for lantern-slide, microscopic and opaque projection, and arrangements are being made for installing a high-class motion picture machine.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four successive years, and to those who hold certificates for each of these courses, a full-term certificate is issued. (See p. 25.)

Holders of full-term certificates are eligible to membership in the Alumni Association. For information in regard to this see page 8.

MUSEUM.

The Museum covers the whole field of natural science and contains illustrations in all depart-

ments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, however, by applying at the office, gain admission to it any week day, except holidays, as above stated, between the hours of 9 a. m. and 5 p. m.

Through the work of Mr. Robert E. Morris, in charge of the taxidermy department of the Institute, a number of new and interesting zoölogical specimens have been mounted and added to the collections during the past year. All the other departments of the museum have also, in the same period, received valuable accessions.

The afternoon museum talks, inaugurated last year, having been very successful, they will be continued during the 1915-1916 season. The details of these talks will be announced as soon as the arrangements for them have been completed.

LIBRARIES.

The reference library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to litera-

ture and an assortment of dictionaries of English, classical and foreign languages. It is open on all regular business days from 9 a. m. to 9.30 p. m., a librarian being always in attendance to assist students.

The circulating library is a branch of the Free Library of Philadelphia. It is open every business day from 9 a. m. to 9 p. m. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

ACCESSORY SCIENTIFIC WORK.

Two scientific societies meet regularly at the Institute. The Philadelphia Natural History Society meets on the third Thursday of each month except June, July and August, the Philadelphia Mineralogical Society on the second Thursday of each month except July and August. These meetings are open to all persons.

UNIVERSITY EXTENSION LECTURES.

Courses of lectures under the auspices of the American Society for the Extension of University Teaching and The Free Library of Philadelphia given in the hall of the Institute are open to all without charge. These courses embrace a wide range of topics, being usually

outside of the scope of the regular Institute courses.

SPECIAL LECTURES.

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics.

Details of lectures already delivered under this foundation are given on page 29.

Arrangements are being made for the publication of these lectures in book form.

The course for the session of 1915–16 is being arranged, and details will be announced in a special publication.

RESEARCH.

The Institute has maintained research work since 1885, and has published seven volumes of transactions. A list of the subjects will be found on pages 27 and 28.

The income of a special fund is available for lectures and research in chemistry.

ALUMNI ASSOCIATION.

The Alumni Association was organized in 1907, composed of those who have received degrees or full-term certificates of the Institute.

The officers for 1915 are:

President, Henry Leffmann.

Vice-Presidents, Daniel G. Alrich, Edward W. Siegmann.

Secretary, Edgar T. Wherry.

Treasurer, W. C. Hambel.

Advisory Council, P. Caledon Cameron, William J. Reinhold, Maximilian Weiss, and the above-named officers.

CLOSING EXERCISES.

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1915, after an address by Professor Samuel T. Wagner, President of the Faculty, and awarding of certificates, Professor Ulric Dahlgren of Princeton University delivered an illustrated lecture on "The Production of Light by Animals."

FULL-TERM CERTIFICATES AWARDED.

ENGINEERING.

William Knabe

INORGANIC CHEMISTRY.

William J. M. Devine

GEOLOGY.

M. G. Biernbaum William Knabe
 Harry W. Trudell

PHYSICS.

Sarah P. Byrnes Thomas Darlington

1914-1915 CERTIFICATES AWARDED.

ENGINEERING 4.

Charles Brackbill George N. Hyland
P. G. Jones Daniel Stewart
Ernest F. Page William Knabe
 Ralph Richter

INORGANIC CHEMISTRY 2.

Thomas Darlington William J. M. Devine
Herbert Haas J. C. Rhodes
 Ralph Richter

ORGANIC CHEMISTRY 2.

William J. M. Devine Herbert H. Haas
E. B. Hassler F. C. Krouse
J. C. Rhodes Ralph Richter

ZOOLOGY 4.

Ralph Richter Nathaniel Speck

BOTANY 4.

Eugene B. Hassler Hugh F. Munro
Ralph Richter Mae E. Sutton

GEOLOGY 4.

M. G. Biernbaum J. S. Frankenfield
William Knabe Sarah Satinsky
 Harry W. Trudell

PHYSICS 1.

P. W. Benkert Herbert H. Haas
Thomas Darlington Hugh F. Munro
John H. Micheals Sarah P. Byrnes
S. D. Rolle F. H. Markle
W. R. Bradway Ralph Richter
 Daniel Stewart

REGULAR LECTURES

SESSION OF 1915-1916.

ENGINEERING 1.

PROFESSOR SAMUEL T. WAGNER.

Materials of Engineering Construction.

Lectures begin at 8 p. m.

1. Friday, September 10.

Properties of Engineering Materials. Force.
Stresses. Properties. Testing machines.

2. Friday, September 17.

Stone. Classification. Composition.
Methods of quarrying.

3. Friday, September 24.

Stone (concluded). Physical properties.
Durability. Unit stresses.

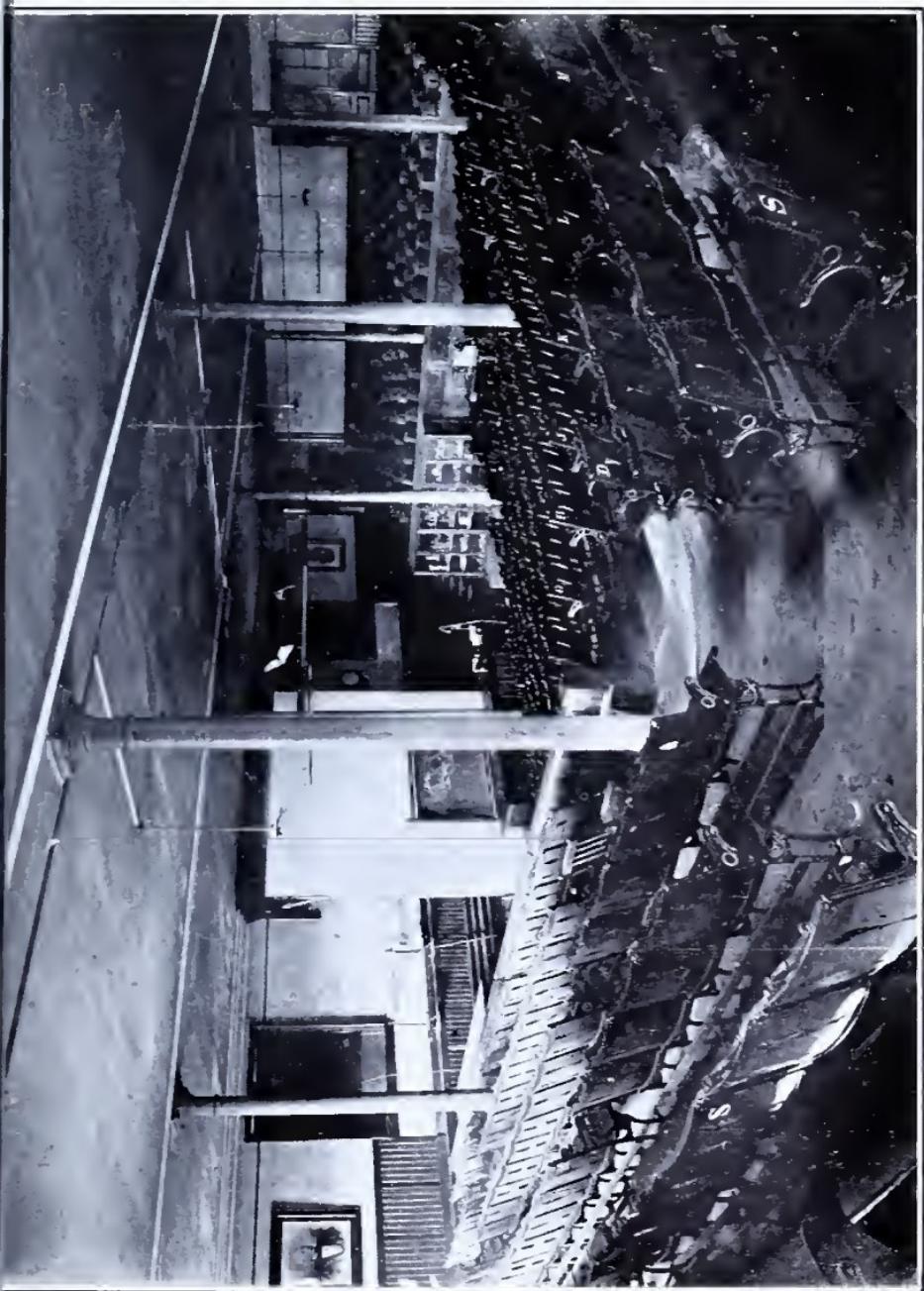
4. Friday, October 1.

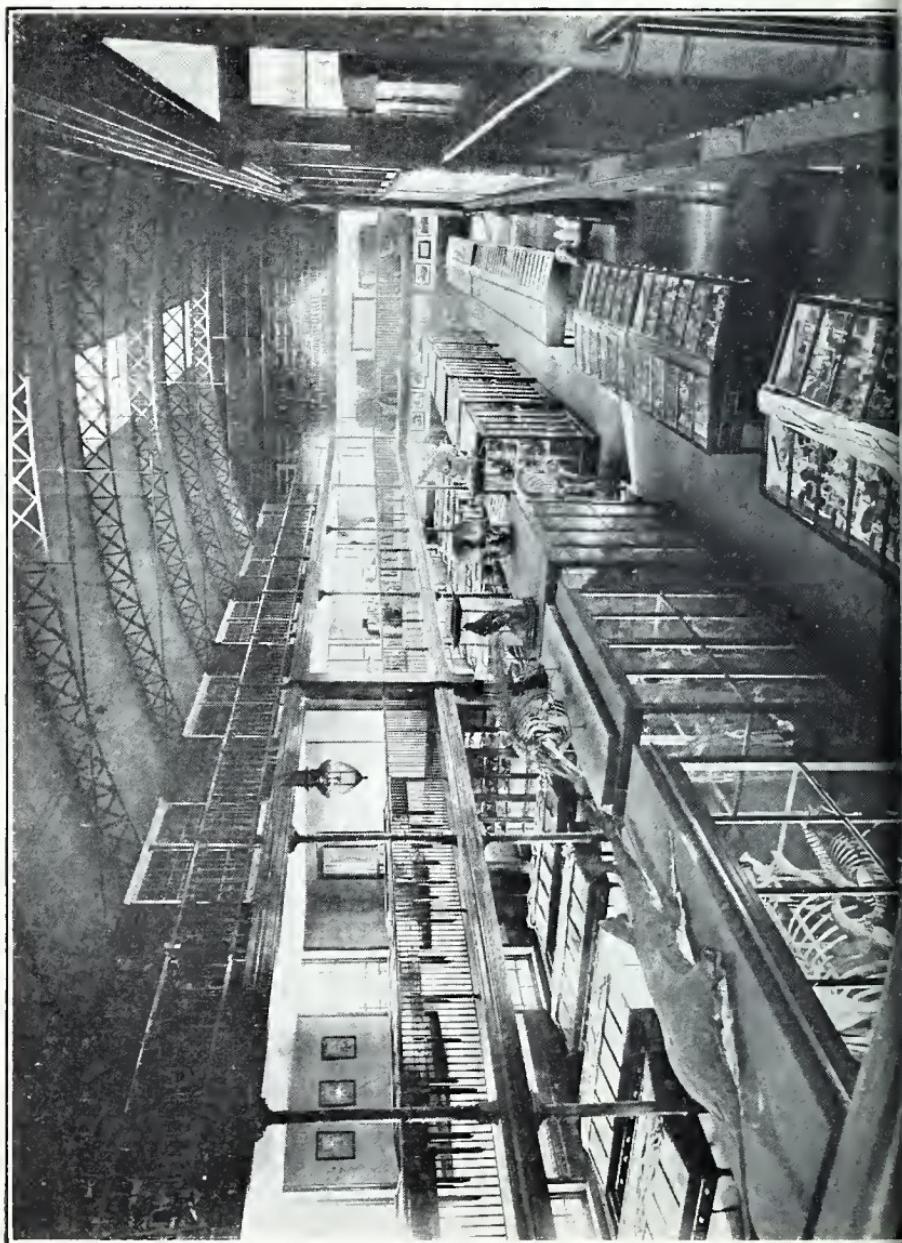
Brick. Composition. Manufacture. Physical properties. Special uses.

5. Friday, October 8.

Lime and cements. Composition and manufacture of lime and its uses. Classification. Manufacture. Physical properties. Tests and uses of Cements.

AUDITORIUM





6. Friday, October 15.

Mortar. Sand. Lime mortar. Cement mortar. Grout. Strength. Uses.

7. Friday, October 22.

Concrete and mastics. Concrete, proportions, mixing, consistency, placing, surface finish. Reinforced concrete: strength, uses. Mastics: Composition, occurrence in nature, uses.

8. Friday, October 29.

Wood. The tree. Composition. Cell structure. Classification. Preparation for the market.

9. Friday, November 5.

Wood (concluded). Seasoning, shrinkage. Durability. Enemies of wood. Preservative processes. Physical properties and unit stresses.

10. Friday, November 12.

Cast iron. Ores of iron. Occurrence in nature. Construction of the blast furnace.

11. Friday, November 19.

Cast iron (concluded). Metallurgy of the blast furnace. Classification of pig iron. Foundry practice. Physical properties and uses.

12. Friday, November 26.

Wrought iron. Chemical and physical composition. The puddle furnace. Physical properties. Unit stresses.

13. Friday, December 3.

Steel. Definition. Alloys with carbon, nickel and chromium. Processes of manufacture. Recarbonization of wrought iron.

14. Friday, December 10.
Steel (continued). Gas producers and their construction. Open hearth process.
15. Friday, December 17.
Steel (concluded). Bessemer process and its limitations. Physical properties, strength, and unit stresses of structural steel.
16. Wednesday, December 22.
Paints. Corrosion of iron and steel. Composition of paints. Theory and application.

ZOOLOGY 1.

PROFESSOR SPENCER TROTTER.

The Phenomena of Animal Life.

Lectures begin at 8 p. m.

1. Monday, October 11.
Conditions of Life. Sense and Action. Chemistry of Living Matter. Factors of Environment.
2. Monday, October 18.
Organization. The Animal compared with a Steam-engine. Problems of Organization. Cell Basis of Structure. Tissues, Organs, and Systems.
3. Monday, October 25.
Mechanism of Circulation. The Blood. The Capillary Network. Unit of Tissue-structure. Lymph. Mechanics of Blood-flow.

4. Monday, November 1.

The Food Problem. Nature of Food. Structure primarily related to Food. Organs of Prehension. Digestive Systems.

5. Monday, November 8.

Metabolism. Intake and Outgo. Tissue Change. Respiration. Secretion and Excretion. Animal Heat.

6. Monday, November 15.

The Sensori-motor Mechanism. Structure of Nervous Tissue. Two Forms. Functional Differences. End Organs. Central Organs. Nature of Nerve-impulses. Muscle locomotion.

7. Monday, November 22.

Animal Life and Intelligence. The Brain. The Basis of Psychic Life. Habit and Instinct. Association. Fibers. Cortical Areas. Memory.

8. Monday, November 29.

Development. Reproduction. Ovum and Sperm-cell. Significance of Sex. Stages of Development. The Embryo and its Relations.

9. Monday, December 6.

Environment. Ecology. Factors of Environment. Problems of Distribution. Place and Time. Animal Relationships.

10. Monday, December 13.

Review. Landmarks of the Science. Darwin and his Theory. Later Phases of Thought. Value of Zoölogy as a Study.

INORGANIC CHEMISTRY 3.

PROFESSOR DAVID WILBUR HORN.

Descriptive Chemistry.

Lectures begin at 8 p. m.

1. Saturday, September 11.

Bromine, Iodine, Fluorine. Sources, preparation, properties, tests, uses.

2. Saturday, September 18.

Sulphur. Occurrence, properties, allotropic forms, sulphides.

3. Saturday, September 25.

Sulphur (continued). Oxides, sulphur acids, properties and uses.

4. Saturday, October 2.

Phosphorus. Sources, preparation, properties, allotropic forms, uses. Hydrogen phosphide. Oxides.

5. Saturday, October 9.

Phosphorus (continued). Phosphoric acids and phosphates. Agricultural and physiological importance of phosphates.

6. Saturday, October 16.

Carbon. Sources, properties, allotropic forms. Diamond and graphite.

7. Saturday, October 23.

Carbon (continued). Coal, hydrocarbons, natural gas, and petroleum.

8. Saturday, October 30.

Carbon (continued). Carbon Oxides. Carbon disulphide, water-gas. Carbonic Acid.

9. Saturday, November 6.

Silicon. Occurrence, preparation, properties. Importance of silicon in mineralogy. Industrial Relations.

10. Saturday, November 13.

Silicates. Glass, pottery. Thermal and optical properties of fused silica. General review of non-metallic elements.

ORGANIC CHEMISTRY 3.

PROFESSOR CHARLES H. LAWALL.

Cyclic Hydrocarbons.

Lectures begin at 8 p. m.

1. Wednesday, October 13.

Destructive Distillation. *Fractional Distillation.* Coal Tar. Wood Tar. Industrial Production and General Uses.

2. Wednesday, October 20.

Fractionating Coal Tar. Commercial Products. Light Oil. Dead Oil. Heavy Oil. Anthracene Oil.

3. Wednesday, October 27.

Benzene and Its Homologues. Theories of Molecular Structure of Cyclic Hydrocarbons.

4. Wednesday, November 3.

Derivatives of Benzene. Aromatic Aldehydes. Alcohols. Esters.

5. Wednesday, November 10.

Derivatives of Benzene (continued). Aromatic Acids, Benzoic, Salicylic, etc.

6. Wednesday, November 17.

Derivatives of Benzene (continued). Phenols. Phenol. Cresol. Resorcinol. Pyrogallol, etc.

7. Wednesday, November 24.

Synthetic Medicines from Coal Tar. The Antipyretics: Acetanilid, Phenacetin, Antipyrin, etc.

8. Wednesday, December 1.

Nitrogen Derivatives of Coal Tar Compounds. Aniline, Its Homologues and Derivatives. Pyridine and Quinoline. Nitrobenzene.

9. Wednesday, December 8.

Dyes From Coal Tar. Classification and General Uses. Indicators.

10. Wednesday, December 15.

Dyes From Coal Tar (continued). Uses in Foodstuffs. Detection and Distinction from Natural Colors.

BOTANY 1.

PROFESSOR SAMUEL C. SCHMUCKER.

THE LIFE OF THE PLANT.

An Elementary Course in Physiologic Botany.

Lectures begin at 8 p. m.

1. Monday, January 3.

The Beginning of Life. The seed and how it behaves. Grains.

2. Monday, January 10.

Hunting Raw Food. How the root grows and the work it does. Vegetables.

3. Monday, January 17.

Stretching for Sun Power. The framework of the plant, temporary and permanent. Trees.

4. Monday, January 24.

Building up Wood. The living material and its stiffening. Timber.

5. Monday, January 31.

Building the Light Trap. The framework and the working tissues. Shade.

6. Monday, February 7.

Imprisoning Sun Power. The energy of the sun and its transformations in the service of life. Power.

7. Monday, February 14.

Preparing for the New Life. The change in branch and leaf to serve for reproduction. Flowers.

8. Monday, February 21.

Improving the Race. Mingling of hereditary strains in the new life. Plant breeding.

9. Monday, February 28.

Preparing to Migrate. The gradual decadence of the old home. Rotation of crops.

10. Monday, March 6.

Hunting the New Home. The Transportation of seeds by water, wind and animals. Fruit.

PHYSICS 2.

PROFESSOR LESLIE B. SEELY.

Sound and Heat.

Lectures begin at 8 p. m.

1. Friday, January 7.

Vibrations in Matter. Relation Between Matter and Energy. Vibratory Motion. Simple Harmonic Motion. Wave Motion. Transverse Waves. Longitudinal Waves.

2. Friday, January 14.

Sound Sensation. Perception of Sound. The Ear. Limits of Hearing. Noise and Music.

3. Friday, January 21.

Properties of Sound Waves. Velocity. Reflection. Echoes. Whispering Galleries. Resonance.

4. Friday, January 28.
Properties of Sound Waves (concluded).
Sympathetic Vibrations. Interference.
Beats.
5. Friday, February 4.
Musical Sounds. Pitch. Quality. Overtones. Resonators.
6. Friday, February 11.
Musical Sounds (concluded). The Musical Scale. Harmony and Discord.
7. Friday, February 18.
Vibrating Strings. How the Pitch of a String is Determined. Nodes.
8. Friday, February 25.
Vibrating Columns of Air. Organ Pipes, Open and Closed. Nodes and Ventral Segments.
9. Friday, March 3.
Heat Effects. Molecular and Atomic Energy. Changes in (a) Volume, (b) Temperature, (c) Molecular Arrangement.
10. Friday, March 10.
Temperature. Temperature Changes, Temperature Measurements. Thermometers, Fahrenheit and Centigrade Scales.
11. Friday, March 17.
Changes in Volume. Coefficient of Linear Expansion. Charles' Law. The Absolute Zero.
12. Friday, March 24.
Changes in Molecular Structure. Latent Heat of Vaporization. Latent Heat of Fusion. Specific Heat.

13. Friday, March 31.

Transmission of Heat. Convection. Conduction. Radiation. Radiant Energy. Infra-red Spectra.

14. Friday, April 7.

Measurement of Heat. The Calorie. The B. T. U. Sources of Heat Energy. Energy of Radio-active Substances.

15. Friday, April 14.

The Mechanical Equivalent of Heat. Transformation of Energy and Heat Losses.

16. Friday, April 28.

Heat Economy. Systems of Heating and of Refrigeration. Heat Insulation.

GEOLOGY 1.

MAYVILLE W. TWITCHELL, PH.D.

Geologic Materials.

Lectures begin at 8 p. m.

1. Wednesday, January 5.

I. *The Science of Geology.* Its nature, scope, subdivisions and methods.

II. *The General Features of Our Planet.* Position. Dimensions. Density. Motions. Division into hemispheres and spheres. Chief features of the Atmosphere, Hydrosphere and Centrosphere.

2. Wednesday, January 12.

I. *The Materials of the Earth's Crust or Lithosphere.* General characteristics. How studied.

II. *Minerals.* What they are. Composition. Chemical properties. How classified.

3. Wednesday, January 19.

The Physical Properties of Minerals. Internal structure. External form. Crystals.

4. Wednesday, January 26.

The Physical Properties of Minerals. Mode of breaking. Hardness. Weight. Color. Luster. Special properties, such as magnetism, phosphorescence, radio-activity, etc.

5. Wednesday, February 2.

Useful Minerals. Part 1. Their distinguishing properties, chief uses and other interesting facts about them.

6. Wednesday, February 9.

Useful Minerals. Part 2. Their distinguishing properties, chief uses and other interesting facts about them.

7. Wednesday, February 16.

Rock-forming Minerals. Part 1. Their distinguishing properties and other interesting facts about them.

8. Wednesday, February 23.

Rock-forming Minerals. Part 2. Their distinguishing properties and other interesting facts about them.

9. Wednesday, March 1.

Rocks. What they are. General properties. How classified.

10. Wednesday, March 8.

Igneous Rocks. Their distinguishing properties and facts of interest about them.

11. Wednesday, March 15.

Sedimentary Rocks. Their distinguishing properties and facts of interest about them.

12. Wednesday, March 22.

Metamorphic Rocks. Their distinguishing properties and facts of interest about them.

13. Wednesday, March 29.

Structural Features of Sedimentary Rocks.
Horizontal and inclined strata. Folds, faults and unconformities. Joints, fissures and veins.

14. Wednesday, April 5.

I. Structural Features of Igneous Rocks.
Dikes, intrusive sheets, bosses, volcanic necks, etc.

II. Structural Features of Metamorphic Rocks. Slaty-cleavage and schistosity.

15. Wednesday, April 12.

Ores and the Forms of Ore-bodies. Typical, valuable, metallic ores as they usually occur.

16. Wednesday, April 19.

I. Fossil Animals and Plants.

II. Freaks of Nature.

GENERAL SCHEDULE OF REGULAR LECTURES.

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING.

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water-supply, Sewers, Canals, Rivers and Harbors.

INORGANIC CHEMISTRY.

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY.

1. General Principles. Aliphatic hydrocarbons.
2. Carbohydrates. Fats, oils and waxes.
3. Cyclic hydrocarbons.
4. Compounds containing nitrogen.

ZOOLOGY.

1. Phenomena of Animal Life.
2. Invertebrate Animals.
3. Vertebrate Animals.
4. The Human Mechanism.

BOTANY.

1. The Life of the Plant.
2. Plant Evolution.
3. The Great Families of Flowering Plants.
4. Ecologic and Economic Botany.

PHYSICS.

1. Properties of Matter. Mechanics.
2. Sound and Heat.
3. Light.
4. Electricity and Magnetism.

GEOLOGY.

1. Geologic Materials.
2. Geologic Processes.
3. Geologic History.
4. Applied Geology.

PUBLICATIONS OF THE INSTITUTE.

- Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. Angelo Heilprin.
- Vol. 2.—Report on Fresh-water Sponges Collected in Florida. Edward Potts.
Notice of Some Fossil Human Bones. Joseph Leidy.
Description of Mammalian Remains from Rock Crevice in Florida. Joseph Leidy.
Description of Vertebrate Remains from Peace Creek, Florida. Joseph Leidy.
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. Joseph Leidy.
On *Platygonus*, an Extinct Genus Allied to the Peccaries. Joseph Leidy.
Remarks on the Nature of Organic Species. Joseph Leidy.

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions
to the Tertiary Fauna of Florida.

William H. Dall.

Vol. 4.—Fossil Vertebrates from the Alaehua
Clays, Florida. Joseph Leidy.

Vol. 5.—Study of Hawaiian Skulls.

Harrison Allen.

Notes on the Palaeontological Publications
of Prof. Wm. Wagner.

William H. Dall.

Vol. 6.—Selenodont Artiodaetys of the Uinta
Eocene. William B. Scott.

Vol. 7.—Contributions to the Mineralogy of
the Newark Group in Pennsylvania.
Edgar T. Wherry.

A Comparative Study of the Radio-
Active Minerals in the Collection of
the Wagner Free Institute of Science.
Carl Boyer and Edgar T. Wherry.

Studies in Carbohydrates.

Charles H. La Wall and Sarah S. Graves.

(Under Department of Chemistry Endowment)

Vegetation of South Florida.

John W. Harshberger.

Ancient Civilization of Babylonia and
Assyria, by Morris Jastrow, Jr., Ph.D.
(Westbrook Free Lectureship Foundation). (In Press.)

LECTURES UNDER RICHARD B. WESTBROOK FOUNDATION.

1912.—Ancient Civilization of Babylonia and Assyria. Morris Jastrow, Jr., Ph.D.

1913.—Conservation of Natural Resources. Gifford Pinchot, Marshall O. Leighton, Overton W. Price, Joseph A. Holmes.

1914.—The Theory of Evolution. William Berryman Scott, Ph.D., LL.D.

1915.—Invisible Light. Robert Williams Wood, LL.D.

